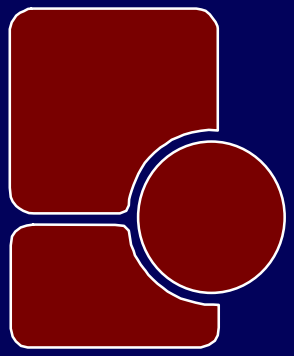
Joint Legislative Audit and Review Commission
of the Virginia General Assembly



Review of Construction Costs and Time Schedules for Virginia Highway Projects

JLARC Staff Briefing
December 19, 2000

Introduction

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Presentation Outline

- [x] **Introduction and Summary of Findings**
- [ ] **Background**
- [ ] **Construction Costs and Time Schedules**
- [ ] **Six Year Development Plan**
- [ ] **Springfield Interchange Improvement Project**

Study Mandate

- In July 2000, the Joint Legislative Audit and Review Commission directed staff to conduct a study of Virginia's highway construction program
- Based on concerns regarding cost overruns and delays in completion of projects, the Commission directed staff to undertake:
  - a study of the six year development plan, and
  - the impact of cost overruns on projects authorized pursuant to the Virginia Transportation Act

Study Issues

- Do road construction project costs exceed cost estimates and amounts budgeted for construction?
- If so, why do final construction costs exceed initial cost estimates and amounts budgeted for construction?
- What are the implications of cost overruns on the current six year development plan?
- Is the six year development plan based on reasonable assumptions?

Study Issues
(continued)

- Will VDOT have adequate cash flow to fund projects in the six year plan on schedule?
- Why have cost estimates for the Springfield Interchange Improvement project continued to rise?
- How long does it take to complete road construction projects and to what extent are projects being delayed?

Research Activities

- **Structured interviews with:**
  - **Chief Engineer, Assistant Commissioner for Finance, State Construction and Location and Design Engineers, Secondary and Urban Roads Engineers, the Director of Programming and Scheduling, and the State Right of Way and Utilities Engineer**
  - **Staff in the Programming and Scheduling and Financial Planning and Debt Management sections**
  - **Staff in the central office Location and Design and Construction divisions and construction managers in districts and residencies**

Research Activities
(continued)

- **Data collection and analysis**
  - Collection and analysis of cost estimate data on 297 recently completed road construction projects
  - Collection and analysis of time data on 292 recently completed road construction projects
  - Application of cost growth factors to 1,907 road construction projects in the current six year development plan

Research Activities
(continued)

- Detailed review of location and design and construction files for 22 road construction projects
- Detailed review of Springfield Interchange Improvement project files and tour of the site
- Review of six year plan financial spreadsheets and available cash flow forecasts
- Attendance of meetings and workshops of the Commonwealth Transportation Board as well as pre-allocation hearings

Summary of Staff Findings

- Project cost estimates developed by VDOT during the design phase of recently completed road construction projects underestimated substantially the cost of these projects
- Final construction costs of recently completed projects exceeded the amount budgeted for construction
- Several factors contribute to low cost estimates and construction overruns including: project scope expansion, lack of adjustments for inflation, and design errors and omissions

Summary of Staff Findings
(continued)

- Current six year plan may underestimate project costs by $3.5 billion and VTA project costs by $2 billion
- Six year plan appears to overstate the amount of funds available for road construction based on questionable assumptions
- Six year plan may be limited by cash flow constraints

Summary of Staff Findings
(continued)

- Springfield Interchange Improvement project appears to be on schedule and has not had major delays, but the estimated cost has increased by 44 percent since July 1999, and the final cost may increase by another $100 million

- Road construction projects take on average three years to design and 13 months to construct and appear to be completed within a reasonable time period

Presentation Outline

- ☐ Introduction and Summary of Findings
- ☑ **Background**
- ☐ Construction Cost Estimates and Time Schedules
- ☐ Six Year Development Plan
- ☐ Springfield Interchange Improvement Project

Three Major Phases of Road Construction

- Preliminary Engineering
  - Scoping
  - Preliminary Field Review
  - Field Inspection
  - Submission of Right of Way Plans
  - Final or 100 Percent Design
- Right of Way
- Construction

Six Year Development Plan

- Current six year plan has $10.3 billion allocated over six years for road construction and transit
  - Approximately $9 billion is allocated for road construction
- The plan includes VDOT's current estimated cost for each project, broken down by preliminary engineering, right of way, and construction
- Based on the recommendation of the Governor's Commission on Transportation Policy, future plans will be divided into feasibility and capital improvement plans

Road Construction Allocations in the Six Year Plan

Funds Allocated for Road Construction (2001-2006)

Fiscal Year	Amount
2001	$ 1,837,298,000
2002	$ 1,289,437,000
2003	$ 1,318,155,000
2004	$ 1,422,256,000
2005	$ 1,380,785,000
2006	$ 1,624,538,000
Total	$ 8,872,469,000

Virginia Transportation Act

- Virginia Transportation Act (VTA) was enacted during the last General Assembly Session to return some delayed projects back to their previous schedule and to provide funding to accelerate some high priority projects
- The VTA provided $473 million over six years in general funds to supplement projects in the six year plan that had been delayed
- The VTA also provided authority for the issuance of federal revenue anticipation notes (FRANs) to raise funds for highway construction

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- ☐ Background
- ☑ **Construction Costs and Time Schedules**
- ☐ Six Year Development Plan
- ☐ Springfield Interchange Improvement Project

Project Costs Are Estimated During the Design Phase

- VDOT develops project cost estimates at the following major milestones during the design process: (1) scoping, (2) preliminary field review, (3) field inspection, (4) approval of right of way plans, and (5) 100 percent design
- At each of these milestones, VDOT staff develop separate cost estimates for preliminary engineering, right of way, and construction

VDOT Budgets an 18 to 25 Percent Contingency Above the Construction Contract Award Amount

- The construction contract award amount is determined through a competitive bid process
  - VDOT Construction division develops internal estimate of construction amount
- VDOT budgets an additional amount equal to ten percent of the construction contract award amount for unforeseen construction costs
- VDOT also budgets an additional amount ranging from eight to 15 percent of the contract award for construction engineering (contract administration and inspections)

Development of Three Primary Cost Growth Factors

- JLARC staff developed three primary cost growth factors to measure the extent to which VDOT may underestimate the cost of road construction projects and the extent to which the final cost of projects exceeds the contract amount
  - Design cost growth factor measures how accurately VDOT staff estimate the cost of projects from design activities to 100 percent design estimate
  - 100 percent design to construction award growth factor measures the percentage change in cost between 100 percent design estimate and the contract award
  - Contract award to final construction cost growth factor measures the percentage change between the contract award amount (including budgeted contingencies) and the final construction cost

Project Costs Are Underestimated Prior to 100 Percent Design

Planning Activity to 100% Design	Average Percentage Change (%)		
	PE	RW	CN
Scoping to 100% Design	114.2	151.9	74.3
Preliminary Field Review to 100% Design	111.7	88.4	52.8
Field Inspection to 100% Design	44.7	65.8	35.7
Furnish Right of Way Plans to 100% Design	13.6	10.6	18.7

Contract Award Amount Is Relatively Close to 100 Percent Design Estimate

Project Type	Average Percentage Change (%)
All Design Projects	3.2
Interstate Projects	8.6
Primary Projects	- 2.4
Secondary Projects	3.9
Urban Projects	8.6

Construction Costs Exceeded Budgeted Amounts by Eleven Percent

Project Type	Average Percentage Change (%)
All Design Projects	11.1
Interstate Projects	18.8
Primary Projects	15.7
Secondary Projects	9.0
Urban Projects	8.1

Construction Costs Exceeded Amounts Budgeted for Contingencies

Project Type	% Project Cost Over Contract Price in Excess of 10% Contingency	% Project Cost Over Contract Price in Excess of Construction Engineering
All Design Projects	7.8	5.0
Interstate Projects	10.5	10.0
Primary Projects	11.8	5.9
Secondary Projects	6.6	4.2
Urban Projects	4.3	4.8

Multiple Factors Explain Low Cost Estimates

- Local requests increase project costs and cause delays
  - Additions requested by localities range from small changes such as landscaping to additional interchanges, bridges, or improvements to local road networks
- Estimates historically have not been adjusted for inflation
- Unforeseen circumstances discovered as preliminary engineering progresses

Multiple Factors Explain Low Cost Estimates (continued)

- Incidental items and contingencies not consistently included in estimates
- Inherent incentives in the system to underestimate projects during the design phase
- Increases in property values as the result of project development

Recommendation

- The Virginia Department of Transportation should review the cost estimation process to determine if additional measures can be taken to improve the accuracy of the process. This should include the development of clear standards regarding the incorporation of incidental items and contingencies in cost estimates in order to improve the consistency of the estimation process.

Design Errors Have Led to Increased Costs and Lengthy Delays

A project to construct high occupancy vehicle lanes on Interstate 264 in the Hampton Roads area experienced work orders and cost overruns totaling $16.5 million over the $35.6 million contract amount, and has been delayed by 537 days. Much of the increased cost was due to numerous design errors, many of which resulted from the in-house design engineer's decision not to conduct a field survey, but to rely instead upon a survey performed more than 30 years earlier. There were numerous elevation errors, inadequate plans for drainage, failure to include necessary materials, underestimates of quantities needed, and failure to include other major elements of the project in the plans. In addition, the design consultant for the bridges failed to include in the design work plans for removal of asbestos in existing bridge structures even though the asbestos was shown on the original bridge plans. The failure to include plans for the removal of asbestos resulted in $2 million in additional costs and a 180-day delay.

Design Errors Have Led to Increased Costs and Lengthy Delays (continued)

An Interstate 81 widening project in Bristol has exceeded the contract amount ($40.4 million) by $14.7 million and could be delayed by more than three years. Much of the cost increase and delay is the result of design errors by the design consultant. Design errors have included incorrect application of geotechnical data, improperly designed retaining walls, and failure to include notes in the design plans regarding bridge overhangs. The file includes several letters from the Federal Highway Administration stating that certain change orders were "due to the carelessness" of the design consultant.

Failure to Detect Problems During Design Phase Has Led to Cost Increases and Time Delays

The widening of Interstate 64 in Newport News exceeded the construction contract amount ($33.5 million) by $24 million and was delayed 538 days. One of the major factors contributing to the increased expense and time delays was the discovery of unsuitable soil after the construction phase of the project began. The geotechnical assessment conducted during the design phase, which was conducted by VDOT staff, did not reveal the problematic soil conditions. VDOT spent an additional $8.5 million in excess of the contract amount to address the soil problem.

Failure to Detect Problems During Design Phase Has Led to Cost Increases and Time Delays (continued)

The reconstruction of the southern approach to the Hampton Roads Bridge Tunnel exceeded the $28.4 million contract amount by $8.5 million and was delayed by almost two years. One of the primary factors contributing to the added cost and delay was the discovery during the construction phase that bridge bearings, which were known to be more than 40 years old, needed to be replaced. The need to replace the bearings was identified during the construction phase when they were cleaned and inspected. The worn bearings had not been discovered during the design phase. The replacement of the bearings cost $5.6 million and delayed the construction project by 590 days.

Recommendation

- The Virginia Department of Transportation should review the preliminary engineering process to assess whether there is adequate management of project design contracts and whether there are adequate procedures in place to minimize errors made in the design of road construction projects. In addition, the department should review whether the preliminary engineering performed for highway construction projects includes an adequate examination of subsurface as well as other field conditions to ensure that all detectable conditions that may impact construction are discovered during the design phase.

Recommendation

- The Virginia Department of Transportation should examine why project construction and construction engineering costs exceed the budgeted contingencies and what measures can be taken to reduce that amount by which contingency amounts are exceeded. Additionally, the department should review whether it adequately budgets for construction contingencies, construction engineering, and other miscellaneous construction expenditures.

On Average, Projects Require Three Years to Complete Design

	Average Months	Minimum Number of Months	Maximum Number of Months
All Design Projects	36	1.0	137.8
Interstate	24	1.0	49.3
Primary	30	6.1	115.8
Secondary	35	9.4	137.8
Urban	66	12.5	87.2

Projects Take Approximately 13 Months to Construct

	Average Number of Months to Complete Construction
Original Time Limit	7.0
Extended Time Limit	6.8
Total Months Approved for Construction	13.8
Months to Complete Construction	13.2

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- ☐ Springfield Interchange Improvement Project

Application of Growth Factors to Current Six Year Plan

- Growth factors were applied to VDOT cost estimates for projects in the current six year plan
- Growth factors applied were based on the project type and the status of the project
- Projects with more than 30 percent of their funding allocated beyond 2006 were not included in the analysis
- Application of the growth factors was based on conservative assumptions

Six Year Plan May Underestimate Project Costs by $3.5 Billion

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Increase in Costs Based on JLARC Cost Growth Factors (Percent)
Overall	$7,856	$11,354	45
Interstate	$2,021	$ 2,911	44
Primary	$2,803	$ 4,002	43
Secondary	$1,408	$ 1,963	39
Urban	$1,624	$ 2,477	53

Six Year Plan May Underestimate VTA Project Costs by $2 Billion

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Increase in Costs Based on JLARC Cost Growth Factors (Percent)
Overall	$4,229	$6,218	47
Interstate	$1,602	$2,407	50
Primary	$2,153	$3,089	43
Secondary	$ 85	$ 120	41
Urban	$ 389	$ 602	55

Status of VTA Projects

Most Recently Completed Planning or Construction Activity	Percentage of VTA Projects (%)
Construction Complete	11
Construction Underway	16
Project in the Location and Design Phase	46
Project Not Yet Initiated	26
Project Status Unknown	1

Implications for Future Highway Construction

- Current plan does not appear to accurately reflect the level of construction that can be achieved over the next six years
- Difficult choices will inevitably have to be made between which projects should proceed and which projects will have to be delayed until adequate funds can be allocated

Implications for Future Highway Construction (continued)

- VDOT recently began taking measures to improve project management, including the quality of the project cost estimates prepared during the initial stages of project design
- It will take several years for VDOT to determine whether these changes will improve the accuracy of the project estimating process and the impact of these changes on future six year plans

Questionable Assumptions May Overstate Amount Available for Road Construction

- Amount available for road construction may be overstated by $379 million
  - Maintenance costs may be underestimated by $201 million based on recent experience
  - Required dedication of funds to public transit may be underestimated by $71 million
  - Plan does not account for $107 million that must be allocated for FRANs principal repayments

Projection of Maintenance Costs Appears to Be Overly Conservative

Fiscal Year	Six Year Plan Projected Annual Maintenance Cost (Millions)	Estimated Annual Maintenance Cost Based on Average Rate of Increase Over the Previous Six Years (Millions)
2001	$ 827	$ 827
2002	$ 848	$ 849
2003	$ 848	$ 872
2004	$ 848	$ 896
2005	$ 848	$ 920
2006	$ 848	$ 945
Total	$5,067	$5,309

Cash Flow Shortfall May Constrain Implementation of Six Year Plan

- Cash flow shortfall forced VDOT to delay 90 projects in 1999
- As of December 1, 2000, VDOT had not yet completed a cash flow forecast that incorporates the additional funds provided pursuant to the Virginia Transportation Act
- Last cash flow forecast showed cash shortage in FY 2001, and, according to the Assistant Commissioner for Finance, VTA funds may not eliminate it

Recommendation

- The General Assembly may wish to consider directing the Virginia Department of Transportation to submit the most recent cash flow forecast, along with assumptions on which the forecast is based, to the Senate Finance and House Appropriations committees on a quarterly basis. The General Assembly may also wish to require the department to regularly report to the committees any projects for which advertisement has been delayed because of cash flow shortages.

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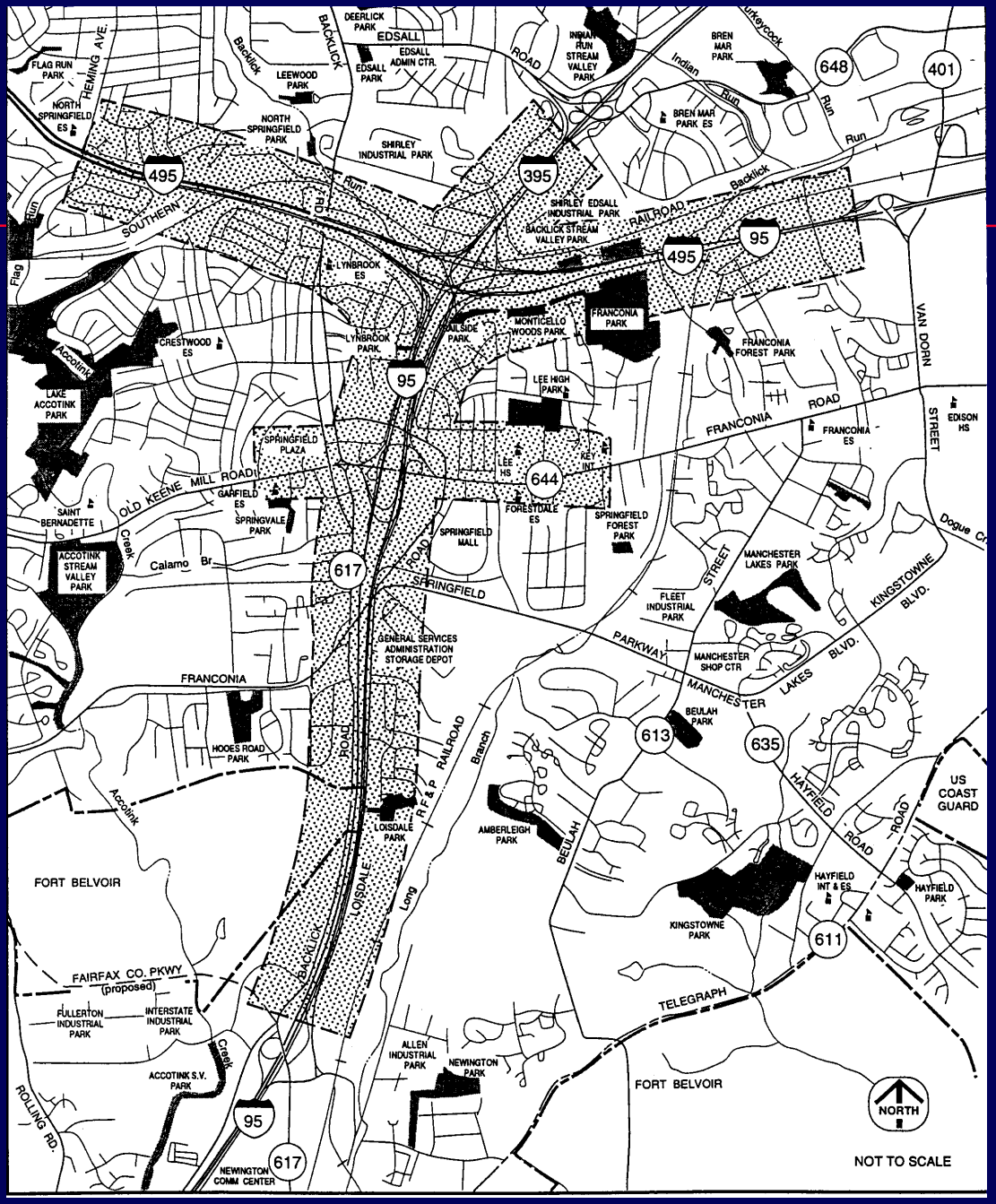
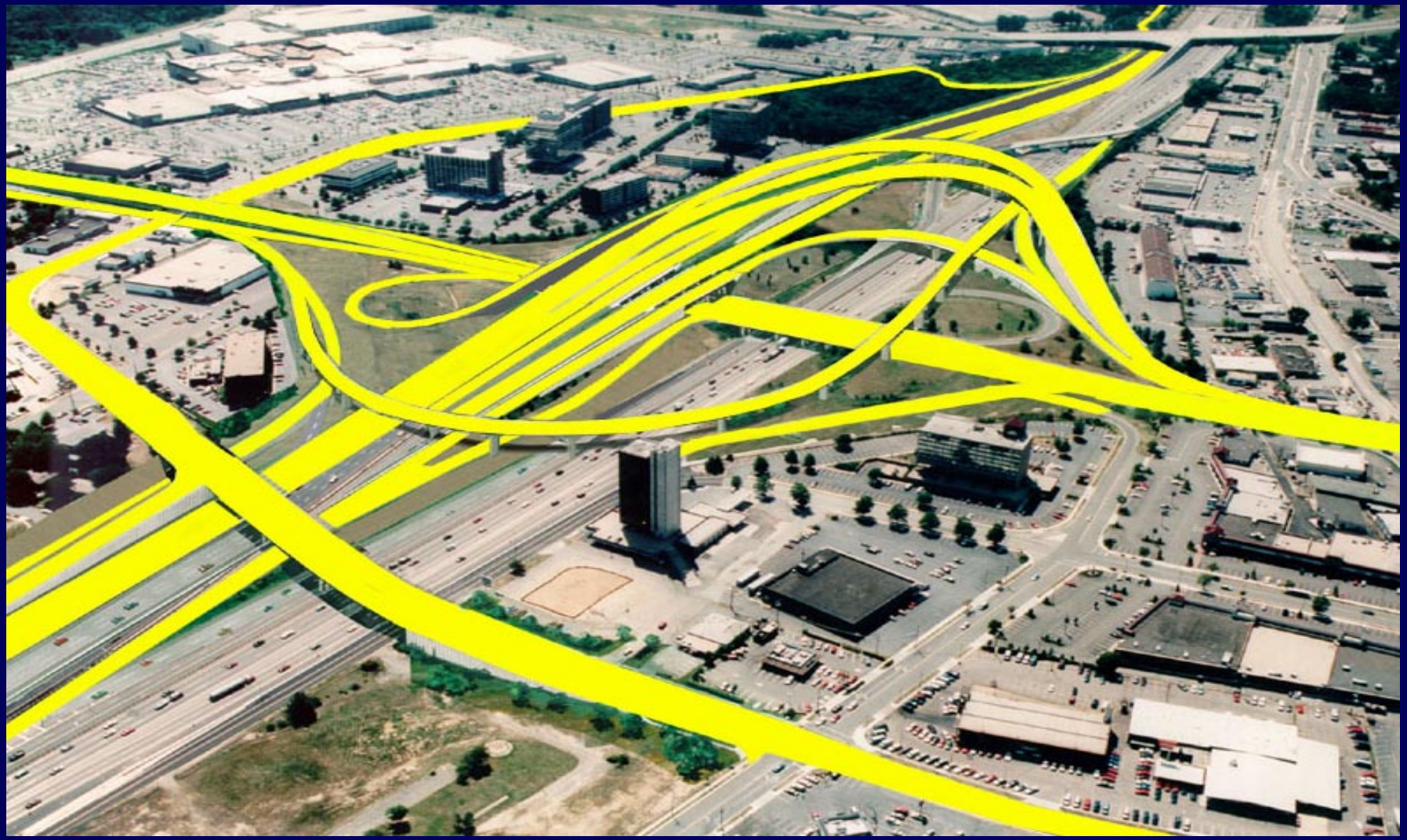
Springfield Interchange Improvement Project

- Located at the intersection of Interstates 95/395/495 in Fairfax County, the project when completed will include 24 travel lanes at its widest point, 50 bridges, and more than 41 miles of roadway
- Project was intended to improve safety and enhance traffic operations from Springfield through the interstate interchange area
- Planning for the project began in 1991 and construction is scheduled to be completed in 2007

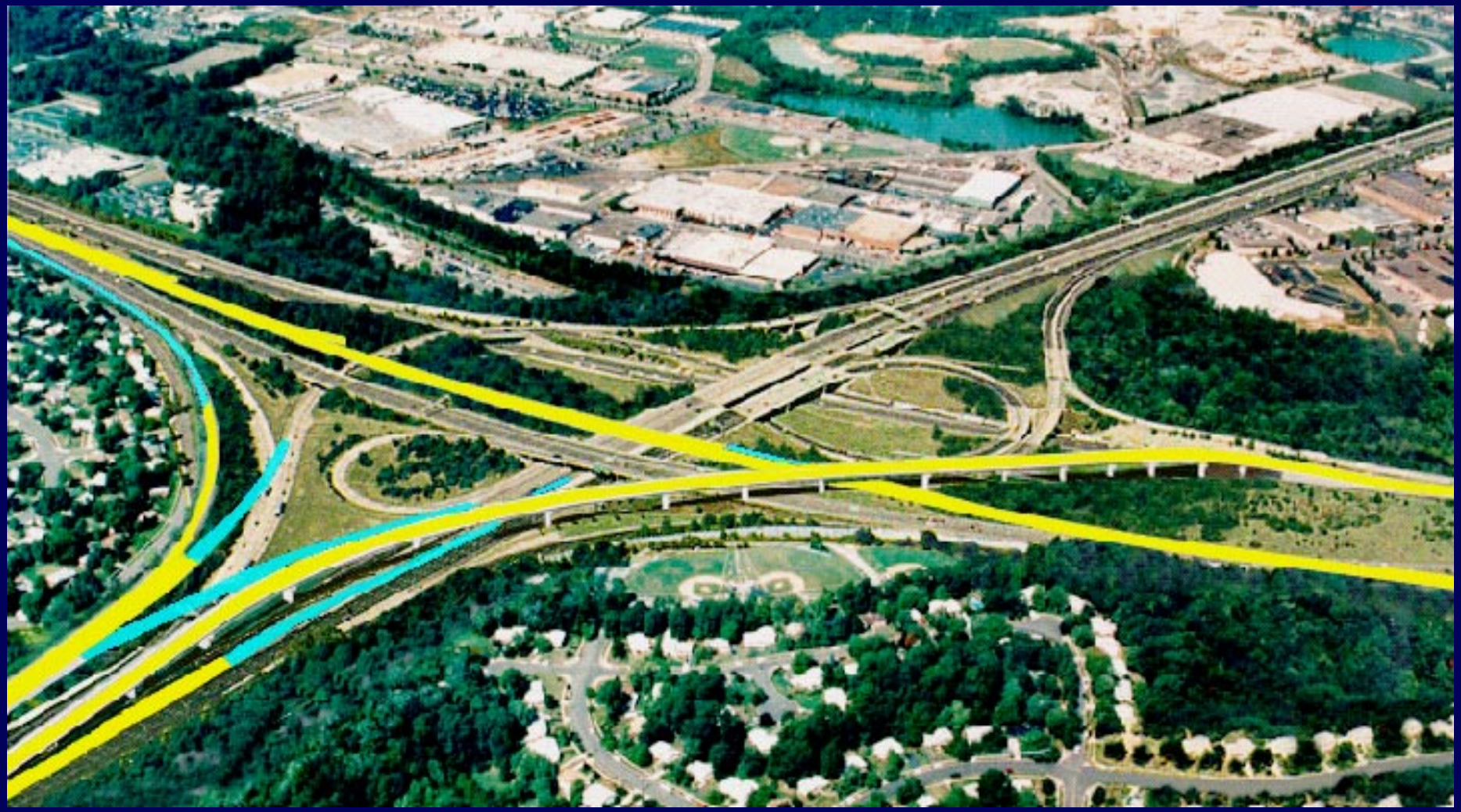
Springfield Interchange Project Area



Phases II & III



Phase IV



Phase V

Phase VI

Phase VII

Project Cost Estimates Have Increased Over Time

Six Year Improvement Plan (Fiscal Year)	Total Estimated Cost	Adjusted Estimate Without Phase VIII
1993	$ 111,000,000	$ 111,000,000
1994	$ 111,000,000	$ 111,000,000
1995	$ 289,650,000	$ 253,150,000
1996	$ 289,850,000	$ 253,350,000
1997	$ 309,152,000	$ 272,652,000
1998	$ 351,959,000	$ 315,459,000
1999	$ 394,389,000	$ 357,889,000
2000	$ 433,550,000	$ 393,550,000
2001	$ 563,295,000	$ 563,295,000

Locality Requests Have Increased Cost by More Than $46 Million

SOV Access to Franconia-Springfield Parkway	**$ 19,700,000***
Ramp from Franconia Road to SB I-95	**$ 9,400,000**
Spring Mall Drive	**$ 7,900,000****
Improvements to Loisdale Road	**$ 3,000,000***
Grade Separation of Franconia Road	**$ 2,700,000****
Amherst Street Bridge	**$ 2,600,000**

* Includes right of way and preliminary engineering costs
** Includes right of way costs

Design Enhancements Have Increased Project Cost by $62 Million

Additional Bridge Work	$ 18,200,000*
Soundwalls	$ 14,900,000
Retaining Walls	$ 10,000,000
Ramp from SB I-395 to NB I-95	$ 9,000,000
Utilities	$ 5,300,000
Widen I-95 Bridges (FHWA)	$ 3,200,000
Additional Lane I-395	$ 1,100,000*

* Includes right of way costs

Other Factors Have Contributed to Increased Cost

- Congestion management has increased cost by $28 million
- Estimates were not adjusted for inflation
- Estimates did not include contingencies
- Estimates did not include design costs or phase I construction costs

Cost Estimate Has Increased at an Accelerated Rate Since July 1999

- Since July 1999, VDOT's estimated cost of the interchange project has increased by $174 million, or 44 percent
- Recent increase results from:
  - Inclusion of construction and construction engineering contingencies ($69.3 million)
  - Increased right of way cost ($34 million)
  - Refined design estimates ($60 million)
  - Adjustment for inflation ($8 million)

Applying Cost Growth Factors, Cost May Reach $667 Million

	VDOT Cost Estimate October 2000	JLARC Estimated Cost
Preliminary Engineering	$ 42,649,000	
Right of Way	$ 68,909,000	
Congestion Management	$ 28,000,000	
Information Store	$ 3,170,000	
Beltway Ramps	$ 689,000	
Phase I	$ 4,818,000	
Cost Incurred to Date	$ 148,235,000	$ 148,235,000
Phase II & III	$ 116,603,000	$ 126,586,000
Phases IV	$ 139,270,000	$ 164,015,000
Phase V	$ 55,700,000	$ 71,862,000
Phases VI & VII	$ 107,608,000	$ 156,186,000
Projected Total Cost	$ 567,416,000	$ 666,885,000

Time Schedules Have Been Adjusted

	Advertisement Date			
Phase	September 1994	April 1998	July 1999	March 2000
I	11/94	11/ 94	11/94	11/94
II & III	7/97	9/98	9/98	9/98
IV	7/03	9/99	3/01	9/00
V	7/05	9/99	3/01	4/01
VI	7/07	9/00	3/03	7/02
VII	7/09	9/00	3/03	7/02

Construction Appears to Be on Schedule

Phase	Advertisement Date	Completion Date
IA	November 1994	August 1996
1B	February 1997	June 1998
II & III	September 1998	June 2002
IV	September 2000	August 2003
V	April 2001	Summer 2003
VI & VII	July 2002	Spring 2007

Conclusion

- VDOT underestimated substantially the cost of recently completed road construction projects, and final construction costs exceeded the amount budgeted for construction
- Current six year plan may not accurately reflect the cost of projects in the plan, and difficult decisions will likely have to be made regarding which projects will receive allocations to proceed
- VDOT recently began taking measures that may help to address the problems of underestimation and unbudgeted cost increases at the construction stage